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RECORD OF ORAL HEARING

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS

AND INTERFERENCES

EX PARTE SRINIVAS DODDI, EMMANUEL DREGE, NICKHIL JAKATDAR, and JUNWEI BAO

Appeal 2008-4716
Application 10/608,300
Technology Center 2100

Oral Hearing Held: December 11, 2008

Before LANCE BARRY, ST. JOHN COURTENAY, III, and CAROLYN D. THOMAS, *Administrative Patent Judges.*

APPEARANCES:

ON BEHALF OF THE APPELLANTS:

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The above-entitled matter came on for hearing on Thursday, December 11, 2008, commencing at 9:00 a.m., at The U.S. Patent and Trademark Office, 600 Dulany Street, Alexandria, Virginia, before Janice A. Salas, Notary Public.

THE CLERK: Calendar number 38, Mr. Yim.

MR. YIM: My name is Peter Yim. Last name is spelled Y-I-M. And I'm here on behalf Timber Technologies. The present application relates generally to metrology of structures that are formed on semiconductor wafers.

The independent claims in particular recite generating a diffraction signal using a machine learning system.

In particular, the claims at issue here and they're rejected by the examiner based on U.S. Patent 6,192,103, the Wormington reference, and the examiner has asserted that the Wormington reference discloses a machine learning system in the form of a genetic algorithm.

We have concurred that Wormington does indeed disclose a machine learning system. Where we have disagreed, however, is that we believe that Wormington clearly discloses using the genetic algorithm to generate a revised parameter set rather than generating a diffraction signal.

And so if I may refer you to figure 4 in the Wormington reference, which sets out the process of doing metrology, it starts with step 30 where an x-ray scattering in this case -- just to be clear, Wormington relates to doing x-ray scatterometry.

So in step 30 they measure an x-ray scattering off of the wafer. In step 32 they generate a model of the structure that they are examining using

a parameter set, not unlike what we do in our process. In step 34 they computed a simulated x-ray scattering.

And at this point if I may turn your attention to column 6 of the Wormington patent, lines 14 through 18.

You see the reference to step 34 in particular reads, "Once the model has been estimated, the x-ray scattering for that model is simulated at step 34 using known methods such as those described in the aforementioned references to produce a characteristic curve."

We believe that the known methods that they're referring to there are discussed in the prior column, column 5, starting at about line 51. It discloses that if the structure of the specimen is known, it's possible to calculate the x-ray scattering data for that specimen using known principles.

In other words, for any given structure, the curve which identifies the characteristic interference, fringe patterns can be simulated and it gives you certain references here that describe how to make that calculation. The important thing here is that it's fairly clear that the simulated scattering is calculated.

And I would distinguish a calculation from what is generally understood to be what happens in a machine learning system. Machine learning systems are generally distinguished from solving an equation, for example. What machine learning systems do is simply form a relationship between inputs and outputs based upon training that you perform.

So there isn't necessarily a function, for example, Y equals some function of X. That's not how a machine learning system --

JUDGE COURTENAY: So it's a more heuristic approach.

MR. YIM: Exactly. Exactly. It's waiting based upon relationships between inputs and outputs. There isn't an explicit calculation that is performed, and it's generally the distinction that's drawn in terms of what makes the machine learning system a machine learning system.

JUDGE THOMAS: So are you saying these references don't include any type of algorithm for this known way of doing this calculation?

MR. YIM: No. I'm saying they do, but what they disclose are ways of actually doing a calculation not using a machine learning system. So they're solving a system of equations, for example, to produce the simulation.

JUDGE THOMAS: How are you defining your machine learning system in respect? I mean, aren't you just saying it's an algorithm that can do this or this or this? You sort of give a laundry list of different types of algorithm that can fall under this machine learning system category, don't you?

MR. YIM: I don't believe that we define a machine learning system to be one that is simply -- one that uses an algorithm. We describe certain types of algorithm that are used in machine learning systems, but what they do is they weigh the relationship between inputs and outputs.

They don't define a specific function between variables, and what we would say is that the term "machine learning system" I believe is very well understood in the art, and people do know when something is a machine learning machine and when something is not, and I don't think that's been disputed in this case between the applicants and the Examiner. For example --

JUDGE THOMAS: If you turn to figure 4, could item 34 --

MR. YIM: Yes.

JUDGE THOMAS: -- be a machine learning system?

MR. YIM: That's the argument that we're presenting you with is that it is not, and it's based on the disclosure here that the simulation is calculated. You would not say that a machine learning system calculates a result. It processes it. As I said, a machine learning system develops a waiting between inputs and outputs, but you do not say that they actually run a calculation.

JUDGE THOMAS: But it receives input. It receives input. It receives these adjusted model parameters and then as the output, you get the x-ray scattering, so you, you know, claim here these are receiving a profile as an input. According to item 34, you're receiving a profile as an input.

MR. YIM: If I may just make --

JUDGE THOMAS: Yes.

MR. YIM: Stepping ahead a little bit to step 40, which does describe the use of a genetic --

JUDGE THOMAS: Yes.

MR. YIM: -- a genetic algorithm, which the examiner and we have agreed that is the machine learning system.

When you look at the disclosure that describes how the genetic algorithm works, you'll see that it doesn't describe a cal -- that the output is calculated, and I think that's the distinction I'm trying to make here is that a machine learning system is not described as calculating a result.

It's solving, in step 32, a system of equations to produce the scattering

in that step. And again, the dispute with the Examiner has not been whether step 34 is a machine learning system or not. The dispute really has been whether the machine learning system that's used in step 40 produces scattering as an output or not.

And one of the arguments that the Examiner has also made is to say that the bounds of the machine learning system that's used in 40 should be extended up to step 34, and we've argued that that's unreasonable, given that the specification clearly describes two different systems that are being used to perform the steps of step 34 and step 40.

And if I may just quickly for step 40 just refer you to column 8, line -- about line 3. It says, "In accordance with the present invention, the adjustment of the model parameters at step 40 to obtain the best fit is carried out with the use of genetic algorithms so preferably a class of genetic algorithms known as evolutionary algorithms."

So we're contrasting between step 34 and step 40 where clearly the genetic algorithm is being used in step 40 to produce adjusted model parameters which are fed back and used to compute additional simulations of the scattering, and the specification clearly describes a process of generating those simulations which are not the use of machine learning systems.

They are computational. They are solving mathematic equations to produce the scattering. And we believe this is also consistent with the claims in the 103 patent as well, just in terms of making it clear that the output of the machine learning system is the -- is the adjusted parameters of the model rather than the x-ray scattering.

I would refer you to claim 1 where you see the second step there being -- estimating a model for the material and calculating simulated x-ray scattering data for the estimated model. And then if you jump ahead two steps, you see Model find the model by means of an evolutionary algorithm to reduce that air value.

We believe that that's consistent with our reading of figure 4 that what you have is that you calculate the simulated x-ray scattering, and the genetic algorithm, which is a machine learning system here, is used to revise the model so that you can get a better fit in the next iteration.

And moreover, if you look at dependent claim 3, which further specifies how the model is modified by use of the genetic algorithm, you will see that the inputs and outputs of that process are parameter vectors.

It recites that the model is modified by computing a plurality of parameter vectors which respectively define different models of the structure that you're examining, generating a test vector, which is based at least in part upon the difference between parameters vectors, comparing an air value for said test vector with an air value for a designated 1 of said plurality of parameter vectors and choosing the vector having the smallest air value as the estimate for the model.

So you see, inputs are models, parameter -- model parameters, and the output are refined parameter values, and I would also, again, sort of going back to this distinction with machine learning systems, it doesn't talk about it calculating it. Like I said, the machine learning systems are, to some extent, viewed as sort of black boxes.

That's why people like them, is because you don't have to define the

relationship within it. The system creates it based upon the training information that you provide to it. And that is discussed to some extent in our specification as well, how, for example, a neuronet functions.

So we believe, based on these, that the examiner is making a clear error in holding that the Wormington reference discloses our claim limitation that the machine learning system produces diffraction signals as the output. And again, I would emphasize here that the claims do not merely recite that there is an output, which is the diffraction signals.

The claims were specifically amended to recite that it's the output of the machine learning system that is the diffraction signal.

JUDGE BARRY: Where specifically in the claim are you talking about?

MR. YIM: For example, in claim 1 --

JUDGE BARRY: Right.

MR. YIM: -- where the machine learning system receives as an input one or more parameters that characterize a profile of the structure to generate the second diffraction signal as an output of the machine learning system. I think it clearly defines what the input of the machine -- to the machine learning system is and what the output of the machine learning system is.

One of the arguments that the examiner has also made in this case is the question of what is an output, and in interpreting figure 4, the examiner basically -- what I believe the examiner's argument was is that he was looking for a formal box, an output box, in figure 4 to say that the output of step 40 would be the adjusted parameter set.

And one, I think there's no such requirement that figures in patent applications need to adhere to those kind of formalistic flow chart requirements. And two, that's just unreasonable and it's illogical.

Clearly, a step is performed and as a consequence to that step, there is a result that is produced, and as we've cited to the portions of the specification, it's clear that the output of the genetic algorithm there are a set of adjusted model parameters.

JUDGE THOMAS: In looking at figure 4, I understand that the output of 40 you are giving these modifying parameters, but that's a loop circuit.

MR. YIM: Yes.

JUDGE THOMAS: Where you're feeding that back into 34 and you're continuously going for a number of iterations.

MR. YIM: Right.

JUDGE THOMAS: In reading the Examiner's reasoning and looking at that, you know, he seems to suggest that it may not be a direct output. Your claim doesn't say directly output from the machine learning system, but somewhere within this loop you do get this x-ray scattering data, which reads on the diffraction signal.

MR. YIM: I would say that that argument carried more weight before the amendment saying that it's the output of the machine learning system. The claim has simply said that there was an output which are diffraction signals.

JUDGE THOMAS: But the first time through, you start with the user guesstimate initial.

MR. YIM: Yes.

JUDGE THOMAS: But the second time and third time and so on through this loop, that output, those x-ray scattering data, is a direct -- has a direct relationship to the output of the machine learning system. They're all interconnected from that point on.

MR. YIM: My argument would be A, the claim language that the -- that it is the output of the machine learning system, while the word "directly" may not be there, would preclude some other process occurring after the machine learning system; otherwise, the sense of it being an output of the machine learning system really have no weight.

And so if you look at figure 4, and what I have articulated before, it's clear that the -- with the machine learning system -- in this case a genetic algorithm is used to perform step 40 and another process is used to perform step 34.

So I believe that would be a very unreasonable reading of the claim language to suggest that output of the machine learning system be the diffraction signal should correspond to this additional process being performed at 34 even in the iteration of the loop.

JUDGE BARRY: So that 34 being in the loop, that precludes it from being an output of the lot 40.

MR. YIM: No. Not by itself. The disclosure in the specification that you do this other calculation, that the simulation is calculated based on the parameters, preclude that being part of the process as performed in step 40, which is the use of the genetic algorithm.

JUDGE COURTENAY: No questions.

JUDGE BARRY: Thank you for your time, counsel.

MR. YIM: Thank you.

(Whereupon, the proceedings were concluded on Thursday, December 11, 2008.)